Falcon Test Checklist Revision 1 (23Apr07)

Serial Number: _____

1 Setup:

Prepare Falcon and computer for testing

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___	Falcon is in test location with access to power cord and USB 2.0 cable
___	USB 2.0 cable NOT connected to Falcon
___	Falcon Power Cord NOT connected to Falcon
___	Volume on test computer is set to an audible level
___	Spherical End Effector is properly installed

2 Test Movement of Falcon Arms:

Manually test Falcon mechanism for smoothness. Success means that mechanical arm assembly was successful.

Yes	No		Pass	Fail	Action on Failure
___	___	Movement of arms while holding Spherical End Effector feels smooth?	Smooth movement.	Difficult to move, excessive bumps or noise.	Stop test. Examine mechanical assembly.
___	___	Top Arm feels smooth when moved?	Smooth movement.	Difficult to move, excessive bumps or noise.	Stop test. Examine mechanical assembly.
___	___	Left Arm feels smooth when moved?	Smooth movement.	Difficult to move, excessive bumps or noise.	Stop test. Examine mechanical assembly.
___	___	Right Arm feels smooth when moved?	Smooth movement.	Difficult to move, excessive bumps or noise.	Stop test. Examine mechanical assembly.

3 USB 2.0 Connection:

Connect Falcon to USB 2.0 on computer. Success means that the computer recognizes the Falcon and that tests can continue.

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___	Connect USB 2.0 cable between Falcon and computer.

Yes	No		Pass	Fail	Action on Failure
___	___	Sound heard when USB 2.0 cable between Falcon and computer were connected?	Sounds heard.	Sounds not heard.	Continue test. Suspect that Falcon Main PCBA is bad or USB communication is not established.
___	___	Some friction and dampening is now felt when Falcon arms are moved?	Movement smooth but more difficult than in Test 2.	Movement not more difficult than in Test 2.	Continue test. Suspect that Falcon Main PCBA is bad or USB port on Falcon is not receiving appropriate current.
___	___	All three (3) LEDs are seen on Novint Falcon Logo Badge?	All three (3) LEDs are turned on and visible.	Less than three (3) LEDs are turned on and visible.	Stop test. Unplug USB 2.0 connection, wait 5 seconds and plug the USB 2.0 connection in again. If test fails again and the golden Falcon passes this same test, repair or replace Main PCBA. If golden Falcon also fails, check USB cable to make sure it is connected. If still fails, reboot computer and try again.

4 Power Connection:

Connect Falcon power supply so that further tests can be done. Success indicates that Falcon power supply is good.

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___	Connect Falcon power supply to A/C mains and to the Falcon.

Yes	No		Pass	Fail	Action on Failure
___	___	LEDs on Falcon Logo Badge get brighter	LEDs get brighter on connecting power supply to Falcon.	LEDs do not get brighter on connecting power supply to Falcon.	Check power supply voltage (30V) . If no voltage make sure power supply is connected to A/C mains. If power supply voltage is below 29V, fail power supply. Get new power supply and continue tests.

5 Novint FalconTest application started with no problems:

Start FalconTest program. Success indicates that the testing program is properly installed on the computer and the tests can continue.

√ ___ Start FalconTest.exe application.

Yes	No		Pass	Fail	Action on Failure
___	___	Novint FalconTest application started with no problems?	FalconTest application comes up and graphical user interface is seen.	FalconTest application graphical user interface is not seen.	Suspect improper FalconTest installation. Reboot the computer and try again. If still failing, discontinue tests until FalconTest program is properly installed.

6 Open USB Communication Link:

√ ___ Select Open button in Communications section of FalconTest application

Yes	No		Pass	Fail	Action on Failure
___	___	LED 1, LED 2 and LED 3 all turned off?	All three Novint Logo LEDs turn off.	One or more Novint Logo LEDs do not turn off.	Suspect that USB communication is not established. Continue test.
___	___	FalconTest application Status indicator in Communication section of FalconTest application turned green?	Status indicator turns green and audible beep is heard. Com Thread Loop Count indicator value should also be increasing quickly.	Status indicator above Open remains off or is yellow or red in color.	Note Error Code (if any). If status indicator remains off, suspect that USB communication controller on Main PCBA has not been programmed or that it has failed. Exit the FalconTest application, remove power cable from Falcon, remove USB cable from Falcon, connect USB cable to Falcon, connect power cable to Falcon and re-start test program. On continued failure, suspect major failure of Falcon Main PCBA. Try golden Falcon and if that works, fail the Falcon being tested. If golden Falcon also fails, re-boot PC and try again. Note that the failed Falcon should be tested with MProg. Run Device->Scan in MProg. If unit not found, major failure of Main PCBA. If unit found but not programmed, program the USB Communication Controller on the Main PCBA.

Error Code (if any): _____

___	___	Friction and damping in Falcon arm movement introduced when USB connection was made is now gone?	Smooth movement as felt in Test 2.	Movement feels the same as in Test 3.	Suspect main PCBA failure or that motors are not properly connected. Continue tests.

7 Novint Logo Badge LEDs:

Tests function and correct placement of Novint Logo Badge LEDs. Continues to verify that USB communication between the computer and the Falcon is working and that the Main PCBA digital signal processor and USB Communication Controller are working.

Yes	No		Pass	Fail	Action on Failure
___	___	Depressing LED 1 button in the LEDs section of the FalconTest application turns on the green LED on the Falcon device?	A green LED on the front of the Falcon lights up.	No LED or an LED of another color lights up.	Note failure condition and at the end of Test 7, discontinue testing and repair Main PCBA so that a working LED or LED of appropriate color is installed.
		If No, check one: _____ No LED _____ Blue LED _____ Red LED			
___	___	Depressing LED 2 button in the LEDs section of the FalconTest application turns on the blue LED on the Falcon device?	A blue LED on the front of the Falcon lights up.	No LED or an LED of another color lights up.	Note failure condition and at the end of Test 7, discontinue testing and repair Main PCBA so that a working LED or LED of appropriate color is installed.
		If No, check one: _____ No LED _____ Green LED _____ Red LED			
___	___	Depressing LED 3 button in the LEDs section of the FalconTest application turns on the red LED on the Falcon device?	A red LED on the front of the Falcon lights up.	No LED or an LED of another color lights up.	Note failure condition and at the end of Test 7, discontinue testing and repair Main PCBA so that a working LED or LED of appropriate color is installed.
		If No, check one: _____ No LED _____ Green LED _____ Blue LED			

8 Buttons on Spherical End Effector

Test function of Spherical End Effector. Failure indicates bad End Effector, incorrect wiring to the end effector interface or failure of end effector communication circuitry on the Main PCBA.

Yes	No		Pass	Fail	Action on Failure
___	___	Depressing Button 1 on Spherical End Effector turned on Button 1 status LED indicator?	The button indicator in the Buttons section of the FalconTest program corresponding to this button lights up brightly in green when the Spherical End Effector button is depressed.	The button indicator in the Buttons section of the FalconTest program corresponding to this button does NOT light up brightly in green when the Spherical End Effector button is depressed.	Suspect that the end effector or the Falcon Base unit are bad. Remove end effector and re-install it. Try test again. If still fails, try golden Spherical End Effector. If Golden end effector passes, then repair/replace end effector that was under test. If golden Spherical End Effector fails, then Falcon Base unit is bad. Test wiring in Falcon Base unit and repair/replace as appropriate. If wiring passes, then Main PCBA has failed. Repair/replace Main PCBA.
___	___	Depressing Button 2 on Spherical End Effector turned on Button 2 status LED indicator?	The button indicator in the Buttons section of the FalconTest program corresponding to this button lights up brightly in green when the Spherical End Effector button is depressed.	The button indicator in the Buttons section of the FalconTest program corresponding to this button does NOT light up brightly in green when the Spherical End Effector button is depressed.	Suspect that the end effector or the Falcon Base unit are bad. Remove end effector and re-install it. Try test again. If still fails, try golden Spherical End Effector. If Golden end effector passes, then repair/replace end effector that was under test. If golden Spherical End Effector fails, then Falcon Base unit is bad. Test wiring in Falcon Base unit and repair/replace as appropriate. If wiring passes, then Main PCBA has failed. Repair/replace Main PCBA.

___	___	Depressing Button 3 on Spherical End Effector turned on Button 3 status LED indicator?	The button indicator in the Buttons section of the FalconTest program corresponding to this button lights up brightly in green when the Spherical End Effector button is depressed.	The button indicator in the Buttons section of the FalconTest program corresponding to this button does NOT light up brightly in green when the Spherical End Effector button is depressed.	Suspect that the end effector or the Falcon Base unit are bad. Remove end effector and re-install it. Try test again. If still fails, try golden Spherical End Effector. If Golden end effector passes, then repair/replace end effector that was under test. If golden Spherical End Effector fails, then Falcon Base unit is bad. Test wiring in Falcon Base unit and repair/replace as appropriate. If wiring passes, then Main PCBA has failed. Repair/replace Main PCBA.
___	___	Depressing Button 4 on Spherical End Effector turned on Button 4 status LED indicator?	The button indicator in the Buttons section of the FalconTest program corresponding to this button lights up brightly in green when the Spherical End Effector button is depressed.	The button indicator in the Buttons section of the FalconTest program corresponding to this button does NOT light up brightly in green when the Spherical End Effector button is depressed.	Suspect that the end effector or the Falcon base unit are bad. Remove end effector and re-install it. Try test again. If still fails, try golden Spherical End Effector. If that unit passes, then repair/replace end effector that was under test. If golden Spherical End Effector fails, then Falcon base unit is bad. Test wiring in Falcon Base unit. If wiring passes, then Main PCBA has failed.

9 Homing Position Encoders:

Tests function of the homing/calibration mechanisms and circuitry of the Falcon. Failure indicates a mechanical issue in the G-Link mechanism, an electrical issue in one of the photo-interrupter PCBAs or an issue with encoder circuitry on the Main PCBA.

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___	Move Falcon arms into Retracted Arm Position
___	Select the Home button in the Homing section of the FalconTest application
___	Move Falcon arms into the Extended Arm Position
___	Move Falcon arms into Retracted Arm Position

Yes	No		Pass	Fail	Action on Failure
___	___	Motor 1 homing status indicator in the Homing section of the FalconTest application turned green ?	The status indicator next to the Motor 1 homing status indicator turns green.	The status indicator next to the Motor 1 homing status indicator remains red.	Move the arms again to Retracted Arm Position, then to Extended Arm Position and then back to Retracted Arm Position. If still failing, stop testing. The Falcon back cover should be removed and the photo-interrupter PCBA outputs should be checked. If any of these PCBAs fail, replace them. In addition, the flags on the G-Links should be checked to make sure that they are properly installed and passing through the photo-interrupter boards. If a flag is missing or mis-installed, install them correctly. If the photo-interrupter PCBAs check-out and the flags look good, suspect the photo-interrupter circuitry on the Main PCBA. Repair/exchange the Main PCBA.

___ ___ Motor 2 homing status indicator in the Homing section of the FalconTest application turned green?	The status indicator next to the Motor 2 homing status indicator turns green.	The status indicator next to the Motor 2 homing status indicator remains red.	Move the arms again to Retracted Arm Position, then to Extended Arm Position and then back to Retracted Arm Position. If still failing, stop testing. The Falcon back cover should be removed and the photo-interrupter PCBA outputs should be checked. If any of these PCBAs fail, replace them. In addition, the flags on the G-Links should be checked to make sure that they are properly installed and passing through the photo-interrupter boards. If a flag is missing or mis-installed, install them correctly. If the photo-interrupter PCBAs check-out and the flags look good, suspect the photo-interrupter circuitry on the Main PCBA. Repair/exchange the Main PCBA.
___ ___ Motor 3 homing status indicator in the Homing section of the FalconTest application turned green?	The status indicator next to the Motor 3 homing status indicator turns green.	The status indicator next to the Motor 3 homing status indicator remains red.	Move the arms again to Retracted Arm Position, then to Extended Arm Position and then back to Retracted Arm Position. If still failing, stop testing. The Falcon back cover should be removed and the photo-interrupter PCBA outputs should be checked. If any of these PCBAs fail, replace them. In addition, the flags on the G-Links should be checked to make sure that they are properly installed and passing through the photo-interrupter boards. If a flag is missing or mis-installed, install them correctly. If the photo-interrupter PCBAs check-out and the flags look good, suspect the photo-interrupter circuitry on the Main PCBA. Repair/exchange the Main PCBA.

10 Motor Torques:

Tests function and appropriate wiring of Falcon motors. Success indicates that motor drive circuitry is working, motors are correctly working and that the motors are correctly wired.

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___ Move Falcon arms to the Retracted Arm Position
___ Set torques of all three motors to 1000 using the All control in the Motors section of the FalconTest application.
___ Pull Spherical End Effector into Intermediate Arm Position.
___ Gently return Spherical End Effector into Retracted Arm Position.

Yes No		Pass	Fail	Action on Failure
___ ___	All arms pull back toward the Retracted Arm Position from Intermediate Arm Position when all motor torques are set to 1000?	All arms are actively pulled by the Falcon towards the Retracted Arm Position.	One or more of the motors do not pull towards the Retracted Arm Position when the Falcon is held in the Intermediate Arm Position.	Stop tests. Check wiring on failed motor(s). If wiring is correct, suspect either motor or Main PCBA motor drive circuitry.

11 Calibration Loss:

	Pass	Fail	Action on Failure

Tests Falcon encoder/position calibration. Success indicates that mechanical encoder wheels are correctly installed and that encoder emitter/detectors are the Main PCBA are working and correctly aligned.

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___		Torques for all three motors set to 1000 and Falcon arms are in the Retracted Arm Position. Encoder 1 indicator reads: _____ Encoder 2 indicator reads: _____ Encoder 3 indicator reads: _____			
Yes	**No**				
___	___	In Retracted Arm Position with Motor 1 torque set 1000, Encoder 1 indicator reads between 1200 and 1600?	Encoder indicator reads between 1200 and 1600 [note: values below 1400 are sub-optimal but pass]	Any value below 1200 or above 1600.	Stop testing. Check placement of G-Link flags. If OK, make sure that G-Link levers are seated. If OK, fail unit and analyze for out of tolerance mechanical components.
___	___	In Retracted Arm Position with Motor 2 torque set 1000, Encoder 2 indicator reads between 1200 and 1600?	Encoder indicator reads between 1200 and 1600 [note: values below 1400 are sub-optimal but pass]	Any value below 1200 or above 1600.	Stop testing. Check placement of G-Link flags. If OK, make sure that G-Link levers are seated. If OK, fail unit and analyze for out of tolerance mechanical components.
___	___	In Retracted Arm Position with Motor 3 torque set 1000, Encoder 3 indicator reads between 1200 and 1600?	Encoder indicator reads between 1200 and 1600 [note: values below 1400 are sub-optimal but pass]	Any value below 1200 or above 1600.	Stop testing. Check placement of G-Link flags. If OK, make sure that G-Link levers are seated. If OK, fail unit and analyze for out of tolerance mechanical components.
√					
___		Torques for all three motors set to 0 and Falcon arms are in the Retracted Arm Position. Move arms in/out quickly 3 times between Retracted and Extended Arm Positions and return the Falcon arms to the Retracted Arm Position.			
___		Torques for all three motors set to 1000 and Falcon arms are in the Retracted Arm Position.			
Yes	**No**				
___	___	In Retracted Arm Position with Motor 1 torque set 1000, Encoder 1 indicator reads: _____ and this value is +/-100 within Encoder 1 value prior to in/out movement of arms?	Encoder indicator is within +/-100 of first reading of this encoder.	Encoder indicator differs from first reading for this encoder by greater than +/- 100.	Stop testing. Failure indicates that the encoder emitter/detector pair on the Main PCBA are incorrectly installed. Open the back of the Falcon and inspect placement and orientation of emitter and detector. Modify as required. Test again. If fails, again, fail the unit and repair/exchange Main PCBA.
___	___	In Retracted Arm Position with Motor 2 torque set 1000, Encoder 2 indicator reads: _____ and this value is +/-100 within Encoder 2 value prior to in/out movement of arms?	Encoder indicator is within +/-100 of first reading of this encoder.	Encoder indicator differs from first reading for this encoder by greater than +/- 100.	Stop testing. Failure indicates that the encoder emitter/detector pair on the Main PCBA are incorrectly installed. Open the back of the Falcon and inspect placement and orientation of emitter and detector. Modify as required. Test again. If fails, again, fail the unit and repair/exchange Main PCBA.
___	___	In Retracted Arm Position with Motor 3 torque set 1000, Encoder 3 indicator read: _____ and this value was +/-100 within Encoder 3 value prior to in/out movement of arms?	Encoder indicator is within +/-100 of first reading of this encoder.	Encoder indicator differs from first reading for this encoder by greater than +/- 100.	Stop testing. Failure indicates that the encoder emitter/detector pair on the Main PCBA are incorrectly installed. Open the back of the Falcon and inspect placement and orientation of emitter and detector. Modify as required. Test again. If fails, again, fail the unit and repair/exchange Main PCBA.
√					
___		Torques for all three motors set to 2000 and Falcon arms are in the Retracted Arm Position.			

Yes	No				
___	___	In Retracted Arm Position with Motor 1 torque set 2000, Encoder 1 indicator reads: _____ and remained stable within +-5 range during 10 second period?	Encoder value does not change more than +/- 5 over 10 second period.	Any change in encoder reading greater than +/- 5 over 10 second period.	Stop the test. The motor capstan is slipping on the shaft or the encoder wheel is slipping relative to the capstan or motor shaft. Check mechanical construction of unit. Make sure that the set screw on the capstan is appropriately tightened and is engaging the flat part of the motor shaft.
___	___	In Retracted Arm Position with Motor 2 torque set 2000, Encoder 2 indicator reads: _____ and remained stable within +-5 range during 10 second period?	Encoder value does not change more than +/- 5 over 10 second period.	Any change in encoder reading greater than +/- 5 over 10 second period.	Stop the test. The motor capstan is slipping on the shaft or the encoder wheel is slipping relative to the capstan or motor shaft. Check mechanical construction of unit. Make sure that the set screw on the capstan is appropriately tightened and is engaging the flat part of the motor shaft.
___	___	In Retracted Arm Position with Motor 3 torque set 2000, Encoder 3 indicator reads: _____ and remained stable within +-5 range during 10 second period?	Encoder value does not change more than +/- 5 over 10 second period.	Any change in encoder reading greater than +/- 5 over 10 second period.	Stop the test. The motor capstan is slipping on the shaft or the encoder wheel is slipping relative to the capstan or motor shaft. Check mechanical construction of unit. Make sure that the set screw on the capstan is appropriately tightened and is engaging the flat part of the motor shaft.

12 Safety/Kill Circuit

		Pass	Fail	Action on Failure
	Tests for proper operations of Falcon safety/kill circuitry in Falcon Main Unit and Spherical End Effector. Success indicates Main PCBA kill circuitry is correct, wiring to end effector interface in the Main Unit is correct and that the Spherical End Effector is working.			
___ √	Torques for all three motors set to 1000 and arms are in retracted position			

Yes	No				
___	___	All arms pull back toward Retracted Arm Position when all motor torques were set to 1000?	All arms are actively pulled by the Falcon towards the Retracted Arm Position.	One or more of the motors do not pull towards the Retracted Arm Position when the Falcon is held in the Intermediate Arm	Stop tests. Check wiring on failed motor(s). If wiring is correct, suspect either motor or Main PCBA motor drive circuitry.
___ √		Remove Spherical End Effector from Falcon Main Unit			
___	___	All arms Stopped pulling back toward Retracted Arm Position when Spherical End Effector was removed from Falcon Main Unit?	Motors do not pull the arms towards the Retracted Arm Position.	Motors continue to pull the arms towards the Retracted Arm Position.	Try test again with a golden end effector. If golden end effector works, repair/replace the tested end effector. If golden end effector fails, check wiring in Falcon Main Unit to make sure that Kill signal is appropriately wired. If signal is appropriately wired, Main PCBA is bad and should be repaired/replaced.
___ √		Re-attach Spherical End Effector from Falcon Main Unit			

Yes	No				
___	___	All arms pull back toward Retracted Arm Position when Spherical End Effector was re-attached?	Motors now pull all the arms towards the Retracted Arm Position.	Motors do not pull the arms towards the Retracted Arm Position.	Try test again with a golden end effector. If golden end effector works, repair/replace the tested end effector. If golden end effector fails, check wiring in Falcon Main Unit to make sure that Kill signal is appropriately wired. If signal is appropriately wired, Main PCBA is bad and should be repaired/replaced.

13 Close USB Communication Link:

√
___ Hit close button

Yes	No				
___	___	Audible beep was heard when communications were closed and Open button in the Communications section of the FalconTest application is available?	Open button is available and Close button is grayed out.	Open button is NOT available and Close button is still active.	Hit the Close button again. If it now works, OK. If not, close the FalconTest Program, hit Open and Close again. If OK then unit is fine. If cannot Open communications, close the FalconTest application, reboot the computer and try Open/Close again. If still not working, the USB Communication Control or digital signal processor on the Main PCBA is likely not working. Fail the Main PCBA board and repair/replace it.

Error Code (if any): _____

√
___ Close FalconTest application.
Note that Falcon Test application MUST be closed between testing different Falcons.

14 Undo Connections:

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___ Unplugged USB 2.0 cable from Falcon
___ Unplugged Falcon Power Cord from Falcon

Done … move onto next unit.